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UNIT REQUIREMENTS FOR PRODUCING MARKET MILK IN EASTERN NEBRASKA.

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CONTENTS.

	Page.
Character and scope of the work	1
Methods of obtaining data	2
Influence of seasons on cost factors	2
Description of herds	3
Requirements for producing milk	3
Credit for calves	6
Credit for manure	7
Requirements for keeping a bull	8
Factors involved in the production of milk	9
Feed	9
Pasture	10
Labor	10
Other costs	11
Percentage comparison of factors involved in milk production	12
Average compared with bulk-line costs	13
Monthly distribution of factors in milk production	15
Summary	15

CHARACTER AND SCOPE OF THE WORK.

How many pounds of grain, hay, and silage do dairymen feed to produce 100 pounds of milk in different sections of the United States? How many hours of labor do they expend? What other costs are involved? In 1915 the Bureau of Animal Industry, United States Department of Agriculture, began a series of studies on groups of dairy farms in different sections of the United States to obtain accurate information along these lines.

The project with which this bulletin deals was organized near Omaha, Nebr., in cooperation with the department of dairy husbandry of the University of Nebraska. The study was begun in September, 1917, but was discontinued at the end of the first year because of the resignation of the field man who was conducting it.[1]

[1] C. H. Cook conducted the field work during the first year.

Note.—The work was carried on in eastern Nebraska in cooperation with the Department of Dairy Husbandry, University of Nebraska, and applies especially to milk shipped from that section to the Omaha market.

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In September, 1919, the work was resumed and records were obtained for the second year. Thus there was an interval of one year between the two years in which the studies were made.

Although the figures obtained show what was required to produce milk for the Omaha market under the system of dairy management found in the section studied, and probably approximate the requirements in similar sections, they, of course, do not apply to dairying in sections where different conditions and methods of management prevail.

METHODS OF OBTAINING DATA.

The figures reported are based on actual records obtained by regular monthly visits of 24 hours each to 8 farms for two entire years and to 22 other farms for one entire year.

At the beginning and end of each year the field agent took an inventory of the dairy buildings, livestock, and equipment used in the care of the herd and its products. On his regular monthly visit at each farm the field agent, with watch in hand, noted and recorded the exact minute each labor operation on the dairy was begun and ended. An equally careful record was obtained of the kind, quantity, cost, and description of each feed fed. The quantity of milk sold and receipts each month were obtained. In addition the milk used by the proprietor and his help or fed to calves was measured or weighed on the monthly visit and used as a basis for determining the quantity kept on the farm during the month.

The dairymen kept itemized accounts of expenses incurred between monthly visits and reported these items to the field agent. Monthly records were kept of the purchase or sale of cows, calves, hides, the cost of outside bull service, and other miscellaneous information. Accurate records of calves born and first-hand information on the condition and methods of handling manure were collected systematically.

The records of all the herds for each month made it possible to obtain representative data for each month, season, and year. Records were obtained the second year as a check on the first year's work and to increase the quantity of data for study.

INFLUENCE OF SEASONS ON COST FACTORS.

The results have been reported separately for the winter and summer seasons because the season of the year may have a marked influence on the principal factors of cost. The months from November to April, inclusive, are considered as the winter season and the months from May to October, inclusive, as the summer season.

The various tables are based upon figures obtained during the two-year study, and the weighted averages of these records were

used wherever they would express the results more accurately. The weighted average was obtained by weighting each item according to its relative importance.

DESCRIPTION OF HERDS.

During the first year records were obtained on 21 herds containing a total of 268.2 cows, with an average yearly production of 5,806 pounds of milk testing 3.6 per cent butterfat. The second year's study included 226.5 cows in 17 herds, with an average yearly production of 5,843 pounds of milk and an average butterfat test of 3.7 per cent. Though most of the herds consisted of grade Holstein cows, there were a number of herds in which the Jersey and Guernsey breeds were well represented. The size of the herd was determined by the number of cows in the herd for 12 "cow-months." Cow-month is a term used to express the record of a cow in the herd for one month.

During the first winter, 43.6 calves were dropped for each 100 cows in the herds, and in summer the ratio was 42.5 calves. During the second winter 58.7 calves were born for each 100 cows kept, and in the second summer 44.2 calves were born. The total of 102.9 calves for each 100 cows for the year may appear excessive, but it is due to the fact that out of the 276 cows in the herd sometime during the year 49 were heifers that entered the herd when they freshened. Though in some cases these cows were in the herd only a few months, the herd was credited with their calves. Thus the herd received credit for the whole calf, whereas the dam was in the herd only a part of the year and was counted only as a proportionate fraction of 1. In this way the percentage of calves was materially affected. Combining the results for the two years, we have a total of 494.7 cows giving birth to 463 calves; or for every 100 cows there were 93.6 calves, 43 of these coming in the summer season and 50.6 in the winter season.

REQUIREMENTS FOR PRODUCING MILK.

The feed requirements are expressed in pounds, and labor in hours, in order to eliminate the effect of fluctuating prices. This method of presenting the facts makes it possible to use the figures for some time to come.

During the war many of the farmers in this section concentrated their efforts on raising grain, which forced dairying to occupy a secondary place. The high price of concentrates caused the dairymen to feed less grain, with the result that the production of the cows was less than it would have been under heavier feeding.

This fact is brought out by the record of a cow named "Prohibition." This cow was so named because she was always dry; at

least it appeared that way to her owner, since she would give milk for only five or six months and then go dry until the next freshening. When her owner found out from the first year's records that she had been dry for six months and had produced only 3,351 pounds of milk during the year, he decided that she should go to the stockyards at Omaha when she went dry again. So, as soon as the cow freshened, the owner began to feed her a little grain to keep her in condition so that it would not take so long to fatten her for beef after she went dry. But Prohibition did not go dry. With that extra grain she kept milking month after month, and at the end of the year she had 7,043 pounds of milk to her credit. The owner did not sell her, but he did change her name.

FIG. 1.—A barn typical of those on the farms studied.

A study of the original figures shows that grain was not fed so economically as it could have been. During the first winter one herd received only 3.8 pounds of grain for each 100 pounds of milk produced, while another herd received 82.5 pounds. Such a wide range in the quantity of concentrates fed was probably due to the fact that the dairy business is relatively new in this section and the most economical methods have not yet been generally adopted by the dairymen. Some dairymen in this section, however, are already following profitable methods of feeding and are giving their herds better care and improving them by breeding and selection. There was also a wide variation between the two winters and between the two summers in the quantity of grain and roughage fed. The wide

difference was accentuated by the fact that an entire year intervenes between the two years during which the records were taken.

The amount of human and horse labor was less than it would have been had the dairymen hauled their own milk. For the most part motor trucks were used to collect the milk and haul it to the Omaha market. The charge for this hauling appears in Tables 1 and 2 under the item "Cash hauling of milk." The item "Motor-truck charge" was payment for the service of a motor truck owned by a dairyman who hauled his own milk.

The cost of keeping a bull is expressed in dollars in Tables 1 and 2. In Table 5 the requirements for keeping a bull for one year are stated in units so that current prices for feed and labor may be applied.

The comparative size and importance of the various cash charges are shown in the lower section of Tables 1 and 2. For convenience the requirements for producing 100 pounds of milk and also for keeping a cow one year are tabulated separately.

TABLE 1.—*Units required, except charge for management, for producing 100 pounds of milk in winter and in summer.*

Item.	Winter.		Summary of two winters.	Summer.		Summary of two summers.
	1917–18	1919–20		1918	1920	
Feed:						
Purchased concentrates.....pounds..	7.0	0.9	4.4	1.4	0.9	1.2
Home-grown grains.....do....	37.9	35.4	36.8	9.1	10.7	9.8
Total concentrates.....	44.9	36.3	**41.2**	10.5	11.6	**11.0**
Hauling and grinding grain.....	$0.007	$0.028	**$0.016**	$0.001	$0.007	**$0.004**
Noncommercial roughage....pounds..	37.3	2.3	22.3	23.1	1.7	12.6
Commercial carbohydrate hay..do....	7.3	4.8	6.3	1.8	3.1	2.4
Commercial legume hay.....do....	29.1	116.8	66.7	47.2	24.9	36.2
Total dry roughage.....	73.7	123.9	**95.3**	72.1	29.7	**51.2**
Silage and other succulent roughage .....pounds..	104.9	78.5	**93.6**	40.2	18.0	**29.3**
Pasture.....	$0.138	$0.069	**$0.108**	$0.608	$0.699	**$0.653**
Bedding.....pounds..	11.0	11.1	**11.1**	.4	.6	**.5**
Labor:						
Human.....hours..	2.1	1.9	**2.0**	2.2	1.6	**1.9**
Horse.....do....	.03	.10	**.06**	.12	.03	**.08**
Other costs:						
Building charges.....	$0.160	$0.222	$0.186	$0.185	$0.199	$0.192
Equipment charges and dairy supplies.	.084	.111	.096	.097	.100	.099
Herd charges: Taxes, insurance, veterinary service, medicines, and disinfectants.....	.037	.024	.032	.043	.022	.033
Interest on cow investment.....	.119	.153	.134	.138	.137	.137
Cost of keeping bull.....	.098	.238	.158	.102	.145	.123
Motor-truck charge.....	.001	.....	.001	.005	.020	.012
Cash hauling of milk.....	.173	.190	.181	.167	.254	.209
Total other costs, except depreciation on cows.....	.672	.938	.788	.737	.877	.805
Depreciation on cows.....	.122	.027	.081	.141	.024	.084
Total other costs.....	$0.794	$0.965	**$0.869**	$0.878	$0.901	**$0.889**

The summaries of the unit requirements by seasons are printed in bold-face type.

TABLE 2.—*Quantities of various classes of feeds required and expenses incurred for keeping a cow during each season and for entire year.*

Item.	Winter.	Summer.	Entire year.
Number of cows	497.1	492.3	494.7
Average production.....pounds..	2,938	2,885	5,823
Feed:			
Purchased.....do....	129	34	163
Home-grown grains.....do....	1,082	284	1,366
Total concentrates.....do....	1,211	318	1,529
Hauling and grinding concentrates	$0.48	$0.12	$0.60
Noncommercial roughage.....pounds..	656	363	1,019
Commercial carbohydrate hay.....do....	183	69	252
Commercial legume hay.....do....	1,959	1,045	3,004
Total dry roughage.....do....	2,798	1,477	4,275
Silage and other succulent roughage.....do....	2,749	844	3,593
Pasture	$3.18	$18.83	$22.01
Bedding.....pounds..	325	15	340
Labor:			
Human.....hours....	58.2	55.4	113.6
Horse.....do....	1.9	2.3	3.2
Other costs:			
Building charges	$5.48	$5.53	$11.01
Equipment charges and dairy supplies	2.81	2.84	5.65
Herd charges: Taxes, insurance, veterinary service, medicines, and disinfectants	.93	.94	1.87
Interest on cow investment	3.93	3.96	7.89
Cost of keeping bull	4.64	3.55	8.19
Motor-truck charge	.01	.36	.37
Cash hauling of milk	5.31	6.06	11.37
Total other costs except depreciation on cows	23.11	23.24	46.35
Depreciation on cows	2.38	2.40	4.78
Total other costs	25.49	25.64	51.13

CREDIT FOR CALVES.

The large credit of 1.02 calves per cow during the second year, as shown in Table 3, was due to many cows entering the herd at freshening time and remaining only a fractional part of the year. The effect of war prices is reflected in the larger average value of calves during the second year.

TABLE 3.—*Total credit for calves produced, by years and by seasons.*

Item.	Credit by years.		Credit by seasons.	
	1917–18	1919–20	Both winters.	Both summers.
Number of calves	231	232	250	213
Total value of calves	$1,752.59	$4,383.50	$3,600.45	$2,535.64
Average value of calves	7.59	18.89	14.40	11.90
Calves per cow	0.86 of 1 calf.	1.02 calves.	[1] 0.5 of 1 calf.	[1] 0.43 of 1 calf.
Credit per cow	$6.53	$19.35	[1] $7.24	[1] $5.15
Credit per 100 pounds of milk	0.01 of 1 calf.	0.02 of 1 calf.	0.02 of 1 calf.	0.01 of 1 calf.

[1] These figures are the averages for the respective seasons.

CREDIT FOR MANURE.

The method used in these studies for obtaining the value of manure takes into consideration the fertilizing constituents of the feeds. The proportion of the fertilizing constituents of the feed that was returned in the manure was obtained from standard tables. A cow digesting her feed utilizes on the average approximately 25 per cent of the nitrogen, 30 per cent of the phosphorus, and 15 per cent of the potash contained in the feed. It is evident, then, that 75 per cent of the nitrogen, 70 per cent of the phosphorus, and 85 per cent of the potash is voided in urine or in the solid portion of the manure. The urine voided by a cow is more valuable than the solid manure as a source of nitrogen and potash.

TABLE 4.—*Manure and fertilizing constituents credited to the herds during the two winters and the two summers.*

Item.	Winter.			Summer.		
	1917–18	1919–20	Average.	1918	1919	Average.
Total manure saved.....tons..	979.1	801.1	890.1	68.9	75.5	72.2
Manure per cow.....pounds..	7,062	7,289	7,162	532	647	587
Manure credited per 100 pounds of milk, pounds.....	234	256	244	19	22	20
	Winter average.			Summer average.		
	Nitrogen.	Phosphoric acid.	Potash.	Nitrogen.	Phosphoric acid.	Potash.
Fertilizing constituents in manure, pounds.....	8,426	2,599	8,753	683	210	710
Credit per cow.....pounds..	33.9	10.5	35.2	2.8	0.9	3.0

The small credit for manure (Table 4) is due to a combination of factors. During the summer the cows are in the barn just long enough to be milked. Only during very cold or stormy days in winter are the cows kept in the barn. On other days they are permitted to run in the stalk fields, where they pick up a little corn and such roughage as they can find. On many farms a considerable quantity of the manure voided in the barns, especially the liquid portion, was lost through leaky gutters. When it was stored in the yards before being spread on the fields a large percentage of the fertilizing value was lost through seepage and exposure to the weather.

Only the manure that was dropped directly on the stalk fields, or was saved, or could have been saved by using reasonable care with the equipment available, was credited to the cows. The quantity of manure dropped was approximated by keeping a record of the time the cows were actually in the barn. This made it possible to

figure the weight of the manure voided in the barn, for, according to the best authorities, a 1,000-pound cow produces 13 tons of manure in a year, or 6½ tons in six months. Full credit was allowed for manure dropped in the stalk fields, but manure dropped in permanent pastures was not credited to the herds. If a credit had been given, an additional charge for fertilizer would have been necessary and would have increased the pasture rent to the herd.

A ton of average manure saved on the farms studied, according to the methods used for determining it, was estimated to contain the following fertilizing constituents:

	Pounds.
Nitrogen	9.5
Phosphoric acid	2.9
Potash	9.8

When the nitrogen in commercial fertilizers was worth 24 cents, phosphoric acid 10 cents, and potash 11½ cents a pound, the fertilizing value of these ingredients in a ton of manure would have been $3.70.

REQUIREMENTS FOR KEEPING A BULL.

On most of the farms the bulls were allowed to run with the cows both in summer and in winter. As shown in Table 5, the bulls received very little grain.

TABLE 5.—*Requirements for keeping a bull, by seasons, based on averages obtained from the equivalent of 29.5 bulls.*

Item.	Winter.	Summer.	Entire year.
Feed:			
Purchased concentrates, pounds	25	10	35
Home-grown grain, do	644	144	788
Total concentrates	669	154	823
Noncommercial roughage, pounds	501	386	887
Commercial carbohydrate hay, do	206	75	341
Commercial legume hay, do	1,757	764	2,521
Total dry roughage, do	2,524	1,225	3,749
Succulent roughage, pounds	2,185	841	3,026
Bedding, do	129	6	135
Pasture	$2.98	$17.41	$20.39
Human labor, hours	10.5	5.6	16.1
Horse labor, do	.....	.3	.3
Other costs:			
Interest on bull investment	$6.30	$6.34	$12.64
Bull's share of buildings	6.07	6.11	12.18
Depreciation on bull	12.77	12.86	25.63
Total other costs	$25.14	$25.31	$50.45

During the second year one of the bulls died and five were sold for beef at prices far below their purebred values. These facts account largely for the depreciation of $25.63 per bull per year.

FACTORS INVOLVED IN THE PRODUCTION OF MILK.

FEED.

Concentrates, in the meaning of this study, are grains and their by-products prepared for feeding.

Home-grown grains are concentrates grown on the farm or in the locality where fed.

Dry roughage includes various hays and other bulky feeds. Dry roughage is subdivided into the three following classes:

Noncommercial dry roughage applies to coarse feeds, such as corn stover and velvet-grass hay, for which price quotations are not given

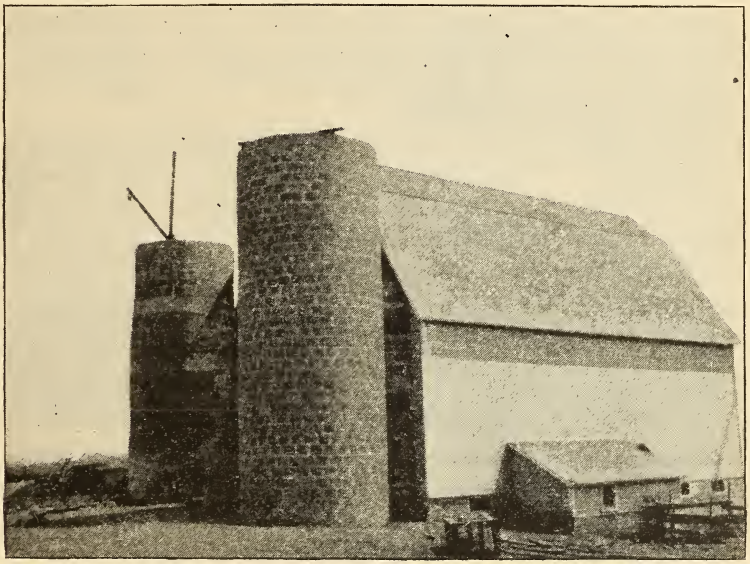

FIG 2.—Barn and silos on one of the farms studied.

in the trade papers. Hay or other dry roughage so foul with weeds or so damaged in curing as not to be readily salable is also classified under this heading.

Commercial legume hay includes alfalfa, clover, cowpea, soy-bean, and other marketable legume hays, when pure, or when so slightly mixed with grasses as not materially to affect the protein content.

Commercial carbohydrate hay refers to all marketable hays except those classified as legume hay.

Succulent roughage consists of mangels, potatoes, silage, and soiling crops.

The quantities of the various feeds used were obtained from actual weights made by the field agent on his regular monthly visit to each farm.

Purchased concentrates were charged at the prices paid. The home-grown grains were given the farm price, plus extra charges for hauling and grinding, when necessary. The value of silage was based upon the value of the grain and roughage in it, less the difference between the cost of harvesting the corn and the cost of putting it into the silo.

PASTURE.

The rent on permanent pasture was obtained by adding the interest and taxes on the land and the upkeep and repairs on fences. Where meadows or stalk fields were pastured, the rent was based upon the prevailing rate in the section, or upon a fair rent based upon the quantity of feed obtained from the field. The rather common practice of allowing the stock to roam at will over fields after the crops had been harvested made it impracticable to express the pasture charge on an acreage basis.

In normal years pastures usually are poor from the last of July until September. During the war the high price of grain tempted many of the farmers to plow up pasture land and sow it to grain, so that the acreage in pastures was greatly reduced.

Sweet clover furnishes good pasture in this section. On one farm 20 acres were sowed to sweet clover, with oats as a nurse crop. The oats yielded 32 bushels an acre, and 15 head of cattle and 8 horses were pastured for two months after the oats were cut. The following summer the sweet-clover pasture carried 18 head of cattle and 8 horses from May to September, inclusive.

On another farm 13⅓ acres of sweet-clover pasture carried 21 cows, 6 calves, and 4 horses from June 1 to September 15. The grazing could have begun a month earlier with beneficial results to the pasture, as the plants were too large and coarse by June 1.

LABOR.

Grain growing is the principal type of farming in this section, and on many farms in summer the herds were cared for and milked late, after the men had done a hard day's work in the fields. Table 6 shows that in summer nearly four-fifths of the work about the dairy was performed by the manager or by the family help. In winter nearly three-fourths of it was performed by the manager with the help of his family.

In all items involving a charge for labor, expressed in dollars and cents, the cost of management has not been included. When the manager worked, his time was charged up at the same price that he would have had to pay if he had hired a man of equal skill to take his place. The reason for not making a definite charge for management is because no satisfactory basis has been found upon which to make this charge.

TABLE 6.—*Percentage of labor performed and hours per 100 pounds of milk by each class of help.*

Class of labor.	Winter.				Summer.			
	Distribution of work performed.			Labor per 100 pounds of milk.	Distribution of work performed.			Labor per 100 pounds of milk.
	1917–18	1919–20	Average.	Average.	1918	1920	Average.	Average.
	Per cent.	*Per cent.*	*Per cent.*	*Hours.*	*Per cent.*	*Per cent.*	*Per cent.*	*Hours.*
Managers	50.9	59.1	54.3	1.07	52.3	49.4	51.1	0.98
Hired men	26.7	26.1	26.4	.52	17.9	25.8	21.1	.41
Total man labor	77.6	85.2	80.7	1.59	70.2	75.2	72.2	1.39
Women	12.1	14.1	12.9	.26	14.	20.6	16.8	.32
Boys and girls	10.3	.7	6.4	.13	15.6	4.2	11.0	.21
Total human labor	100.0	100.0	100.0	1.98	100.0	100.0	100.0	1.92

As is seen in Table 7, work connected with the dairy is divided into three groups—production, handling, and hauling to the shipping platform. Production includes feeding, milking, and the general care of the herd. Handling comprises such items as washing the utensils, cooling the milk, and getting it ready for hauling. On one farm hauling to the market was done by the owner himself; on the others it was done by a motor truck which called at the dairies and picked up the milk which had been hauled short distances to the road on the route of the truck. The item of hauling in Table 7 does not include the time taken by the motor trucks, as it was paid for in cash.

TABLE 7.—*Human labor used in producing, handling, and hauling 100 pounds of milk to the shipping platform.*

Kind of work.	Winter.				Two winters.		Summer.				Two summers.	
	1917–18		1919–20				1918		1920			
	Hours.	*Per ct.*	*Hours.*	*Per ct.*	*Hours.*	*Per ct.*	*Hours.*	*Per ct.*	*Hours.*	*Per ct.*	*Hours.*	*Per ct.*
Production	1.89	92.3	1.71	90.8	1.81	91.7	1.93	86.3	1.41	88.2	1.67	87.1
Handling	.13	6.3	.13	6.9	.13	6.6	.27	12.3	.15	9.2	.21	11.0
Hauling	.03	1.4	.04	2.3	.04	1.7	.03	1.4	.04	2.6	.04	1.9
Total	2.05	100.0	1.88	100.0	1.98	100.0	2.23	100.0	1.60	100.0	1.92	100.0

OTHER COSTS.

Under the heading of "other costs" are grouped miscellaneous costs, such as interest, taxes, insurance, and depreciation, on the herd, buildings, and equipment, also the cost of keeping the bull, and similar items.

BUILDINGS.

The investment in buildings, including silos, averaged $85.16 per cow per year. The depreciation per year was based upon their remaining years of usefulness. Insurance charges were taken from

the premium receipts of the insurance companies. The cost for upkeep and repairs was obtained by keeping an actual record of expenditures during the year. The footing of the first column of Table 8 shows that the total of the costs against buildings amounted to 13.8 per cent of the capital invested in buildings, and the other totals show corresponding percentage relationships.

TABLE 8.—*Per cent relationship between "other costs" and capital invested.*

Item.	Buildings.	Equipment.	Herd.	Total.
Capital invested	$421,127.96	$9,805.62	$66,501.50	$118,435.08
Capital invested per cow	85.16	19.82	134.43	239.41
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Interest	6.0	5.9	5.9	
Depreciation	3.4	15.2	3.6	
Taxes	.7		.6	
Insurance	.4		.3	
Upkeep and repairs	3.3	.9		
Milking-machine repairs		.9		
Total	13.8	22.9	10.4	12.6

EQUIPMENT.

A monthly record of repairs and renewals of equipment was made. The amounts spent for dairy supplies were also recorded month by month and amounted to $1.12 per cow per year.

HERD.

The cows had an average inventory value of $134.43. Purebred cows were inventoried at fair prices for grade animals of similar producing ability, and the calves dropped by the purebred cows were inventoried at corresponding grade values. Inventories were taken at the beginning and end of each year. The value of cows which entered the herd during the year was added to the first inventory, and the receipts for cows or hides sold during the year were added to the second inventory before determining the depreciation or increase in value of the herd for the year.

The feed, labor, and "other costs" of keeping the herd sires were kept separate, so they would be available for study. Interest was charged at 6 per cent, the prevailing rate in the section. Records were kept of the actual amounts of money spent during the year for veterinary services, medicines, and disinfectants. These expenditures amounted to 60 cents per cow per year.

PERCENTAGE COMPARISON OF FACTORS INVOLVED IN MILK PRODUCTION.

How much more did it cost to produce milk in winter than in summer? What caused the variation in cost? Did the credit for calves and manure and the debit for "other costs" balance each other? Table 9 answers these questions.

TABLE 9.—*Percentage of the total costs represented by feed, labor, and other costs, by seasons.*

Cost item.	Winter.	Summer.	Entire year.
	Per cent.	*Per cent.*	*Per cent.*
Feed and bedding	33.4	10.9	44.3
Pasture	1.7	10.0	11.7
Feed, bedding, and pasture cost	35.1	20.9	56.0
Labor	8.9	7.9	16.8
Other costs except herd inventory variation	12.3	12.3	24.6
Total cost except herd inventory variation	56.3	41.1	97.4
Depreciation on herd	1.3	1.3	2.6
Total cost of production	57.6	42.4	100.0
Credits:			
Calves	3.6	2.6	6.2
Manure	6.9	.5	7.4
Total credits	10.5	3.1	13.6

The first two columns of Table 9 show that the difference of 15.2 per cent in the cost of producing milk in winter and in summer was due principally to the difference in cost of the feed, bedding, and pasture.

The high prices received for cows sold tended to reduce the depreciation charge. The depreciation charge is reported separately, so that the amount and its effect on the total cost can be seen.

AVERAGE COMPARED WITH BULK-LINE COSTS.

During the last few years attempts have been made to use the average cost of production as a basis for determining the selling price of milk. Where the average cost basis is recommended it is evident that practically all those producers whose costs are above the average will find their profits small even if they are so fortunate as not to suffer an actual loss. This will tend to discourage production and reduce the available supply.

It is to be expected that the cost of producing 100 pounds of milk will vary in different dairies and in the same dairy from season to season. The varying costs per 100 pounds of milk have been tabulated in ascending order in Table 10.

In the scale of costs there is a line below which the greater quantity of the milk is produced. This is known as the bulk line. The determination of the limits of the bulk-line cost depends in part upon the supply needed. However, it is usually set at some point which includes from 80 to 90 per cent of the total supply. An examination of the second, fourth, and fifth columns of each season in Table 10 shows one or more points where the bulk line could be located. It will be noted that during the winter of 1919–20, 82.5 per cent of the milk was produced at a cost of $3.45 or less per hundred. At $3.51 or less 86.7 per cent of the total supply of milk was produced. Thus 4.2 per cent more milk was obtained at an increased cost of 6 cents per hundred. Then there was a sharp

advance to $3.85 in the cost of production with only a small quantity of milk, 6.5 per cent, produced. If the price of milk is based on the cost of production, one should ask whether 6.5 per cent more milk is worth an increase of 34 cents ($3.85 minus $3.51) per 100 pounds. In this range of costs one logical location for the bulk line is at $3.51, since this figure includes 86.7 per cent of the total quantity of milk produced. It is not logical to locate the bulk line at $3.85, since there is an increase of 34 cents in cost and only 6.5 per cent additional milk supplied. When all the present supply is needed, the supply will be maintained if the price for milk is sufficiently above the bulk-line cost to encourage increased production by the low-cost producers.

TABLE 10.—*Net cost, quantity, and percentage of milk produced by each herd during two winters and two summers.*

Winter, 1917–18.					Winter, 1919–20.				
Herd No.	Cost per 100 pounds.	Milk produced.			Herd No.	Cost per 100 pounds.	Milk produced.		
		Quantity.	Proportion of total.	Cumulative proportion.			Quantity.	Proportion of total.	Cumulative proportion.
		Pounds.	*Per cent.*	*Per cent.*			*Pounds.*	*Per cent.*	*Per cent.*
423	$2.01	10,490	1.2	1.2	433	$2.21	40,301	6.4	6.4
402	2.02	187,691	22.5	23.7	426	2.27	35,839	5.7	12.1
417	2.08	64,061	7.6	31.3	425	2.59	15,754	2.5	14.6
421	2.51	26,600	3.2	34.5	431	2.60	37,052	5.9	20.5
420	2.62	30,424	3.6	38.1	417	2.69	57,972	9.3	29.8
	[1] 2.73				432	2.70	35,891	5.7	35.5
415	2.79	44,843	5.4	43.5	427	2.78	41,388	6.6	42.1
410	2.85	59,013	7.0	50.5	420	3.04	33,790	5.4	47.5
	[2] 2.86				434	3.10	65,751	10.5	58.0
404	2.88	19,201	2.3	52.8	403	3.15	18,913	3.0	61.0
403	2.94	14,181	1.7	54.5		[2] 3.18			
408	2.98	72,048	8.6	63.1	404	3.21	9,181	1.5	62.5
418	3.01	30,814	3.7	66.8	428	3.41	36,639	5.9	68.4
409	3.07	26,004	3.1	69.9	429	3.45	87,840	14.1	82.5
416	3.19	27,425	3.3	73.2		[1] 3.47			
407	3.26	23,658	2.8	76.0	409	3.51	25,990	4.2	86.7
411	3.41	22,706	2.7	78.7	416	3.85	40,428	6.5	93.2
406	3.58	33,617	4.0	82.7	405	4.39	19,083	3.1	96.3
413	3.64	27,045	3.2	85.9	410	6.96	23,362	3.7	100.0
412	3.78	49,084	5.9	91.8					
405	4.12	23,741	2.8	94.6					
419	4.28	32,655	3.9	98.5					
422	4.62	9,937	1.5	100.0					
Summer, 1918.					Summer, 1920.				
423	$1.15	29,663	4.1	4.1	427	$1.62	48,401	6.9	6.9
403	1.50	37,931	5.2	9.3	429	1.76	75,467	10.8	17.7
421	1.80	35,688	4.9	14.2	404	1.77	27,932	4.0	21.7
416	2.13	40,062	5.5	19.7	425	1.80	37,494	5.4	27.1
410	2.24	40,671	5.6	25.3	416	1.83	55,053	7.9	35.0
415	2.26	32,944	4.6	29.9	420	1.91	40,468	5.8	40.8
408	2.41	72,138	10.0	39.9	434	2.20	87,176	12.5	53.3
407	2.43	30,531	4.2	44.1	403	2.26	26,907	3.9	57.2
404	2.45	21,366	3.0	47.1		[2] 2.38			
	[1] 2.59				426	2.47	29,098	4.2	61.4
409	2.66	22,520	3.1	50.2	417	2.69	56,058	8.0	69.4
	[2] 2.74					[1] 2.70			
406	2.88	26,539	3.7	53.9	433	2.80	45,057	6.4	75.8
411	2.90	19,335	2.7	56.6	409	2.90	29,688	4.3	80.1
417	3.02	49,170	6.8	63.4	432	2.95	28,937	4.1	84.2
402	3.18	59,736	8.3	71.7	431	3.26	24,335	3.5	87.7
422	3.35	12,975	1.8	73.5	410	3.38	25,568	3.7	91.4
412	3.36	59,565	8.2	81.7	428	3.52	40,744	5.8	97.2
420	3.37	26,434	3.7	85.4	405	3.95	19,814	2.8	100.0
418	3.50	30,042	4.2	89.6					
419	3.78	33,636	4.7	94 3					
413	4.16	18,509	2.6	96.9					
405	4.35	22,456	3.1	100.0					

[1] Average income from milk. [2] Average cost.

MONTHLY DISTRIBUTION OF FACTORS IN MILK PRODUCTION.

During the last few years many dairymen have requested an analysis of the cost of producing milk on a monthly basis. Such an analysis is given in Table 11.

TABLE 11.—*Distribution, by months, of milk prices, milk produced, feed cost, and labor required.*

Month and season.	Income per 100 pounds of milk.	Income from milk sold and used.	Milk, sold and used.	Feed, pasture, and bedding cost.	Feed, pasture, and bedding cost minus manure and bedding credit.	Human labor.		Horse labor.	
						Per 100 pounds of milk.	Per cow.	Per 100 pounds of milk.	Per cow.
1917–18.		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*
May	$2.39	9.2	10.2	6.8	6.7	2.0	11.3	0.138	0.79
June	2.31	8.1	9.4	6.0	5.9	2.1	11.2	.041	.23
July	2.43	7.4	8.2	6.3	6.1	2.4	11.6	.056	.27
August	2.64	6.9	6.9	5.6	5.5	2.5	10.1	.313	1.28
September	2.88	6.8	6.3	7.5	7.4	2.3	8.7	.137	.52
October	3.27	6.6	5.4	5.9	5.7	2.4	8.9	.090	.34
Summer	2.59	45.0	46.4	38.1	37.4	2.2	10.4	.124	.58
November	2.78	7.7	7.4	7.8	5.9	2.1	9.1	.034	.15
December	2.87	8.7	8.0	10.8	8.9	2.2	12.3	.034	.16
January	2.80	9.7	9.2	12.1	10.1	2.1	11.3	.025	.13
February	2.80	9.0	8.6	11.1	9.1	2.1	10.3	.026	.13
March	2.72	10.4	10.2	11.3	9.4	1.9	10.8	.034	.19
April	2.48	9.5	10.2	8.8	6.8	1.9	10.0	.051	.27
Winter	2.73	55.0	53.6	61.9	50.1	2.1	10.3	.034	.17
Year	2.67	100.0	100.0	100.0	87.5	2.15	10.35	.079	.375
1919–20.									
May	2.87	9.6	10.3	7.2	7.0	1.5	8.6	.04	.21
June	2.31	8.6	11.4	7.3	7.1	1.4	9.1	.01	.09
July	2.40	7.9	10.2	5.8	5.6	1.4	7.9	.02	.11
August	2.62	6.9	8.1	4.7	4.5	1.7	7.3	.02	.10
September	2.89	6.7	7.1	4.6	4.4	1.8	7.2	.02	.08
October	3.58	6.7	5.7	7.1	6.9	2.2	7.7	.11	.40
Summer	2.70	46.4	52.8	36.7	35.5	1.6	8.0	.03	.15
November	3.69	7.1	5.9	8.2	6.0	2.1	7.7	.11	.39
December	3.74	8.7	7.1	12.1	9.9	1.9	8.4	.10	.47
January	3.59	9.9	8.4	12.3	10.0	2.0	10.6	.19	.98
February	3.43	9.2	8.2	12.2	10.0	2.0	9.5	.09	.43
March	3.36	9.6	8.8	10.0	7.8	1.8	9.5	.06	.31
April	3.15	9.1	8.8	8.5	6.3	1.5	7.8	.08	.39
Winter	3.47	53.6	47.2	63.3	50.0	1.9	8.9	.10	.49
Year	3.06	100.0	100.0	100.0	85.5	1.75	8.45	.065	.32

The third column of Table 11 shows the percentage of the yearly income from milk which was obtained each month. The percentage of the yearly quantity of milk produced each month is found in the fourth column. The fifth column shows the monthly feed, pasture, and bedding cost to produce milk, and the sixth shows the same costs after the credit for manure and bedding has been deducted. The remaining columns show the amounts of labor expended for producing 100 pounds of milk, and also for keeping a cow.

SUMMARY.

The requirements for producing 100 pounds of milk were obtained from records covering two one-year periods with an interval of one year between them. During the winter six months these requirements were: Concentrates, 41.2 pounds; hauling and grinding concentrates, $0.016; dry roughage, 95.3 pounds; silage and other

succulent roughage, 93.6 pounds; pasture, $0.108; bedding, 11.1 pounds; human labor, 2 hours; horse labor, 0.06 hour; total other costs except depreciation on cows, $0.788; depreciation on cows, $0.081. During the summer six months there were required: Concentrates, 11 pounds; hauling and grinding concentrates, $0.004; dry roughage, 51.2 pounds; silage and other succulent roughage, 29.3 pounds; pasture, $0.653; bedding, 0.5 pound; human labor, 1.9 hours; horse labor, 0.08 hour; total other costs except depreciation on cows, $0.805; depreciation on cows, $0.084. (Table 1.)

The requirements for keeping a cow one year were: Concentrates, 1,529 pounds; hauling and grinding concentrates, $0.60; dry roughage, 4,275 pounds; silage and other succulent roughage, 3,593 pounds; pasture, $22.01; bedding, 340 pounds; human labor, 113.6 hours; horse labor, 3.2 hours; total other costs except depreciation on cows, $46.35; depreciation on cows $4.78. (Table 2.)

There was a credit, per year, of 0.93 of 1 calf for each cow, which amounted to 0.03 of 1 calf for each 100 pounds of milk produced. (Table 3.) The credit for manure per cow per year amounted to 7,749 pounds, and for 100 pounds of milk it amounted to 264 pounds. (Table 4.) It was estimated that a ton of this manure contained 9.5 pounds of nitrogen, 2.9 pounds of phosphoric acid, and 9.8 pounds of potash. (Page 8.)

In the winter season 54.3 per cent of the work was performed by the manager, 26.4 per cent by the hired men, 12.9 per cent by women, and 6.4 per cent by boys and girls. During the summer 51.1 per cent was performed by the manager, 21.1 per cent by hired men, 16.8 per cent by women, and 11 per cent by boys and girls. (Table 6.)

The building costs for the year were 13.8 per cent of the capital invested in them, the equipment costs were 22.9 per cent of the capital invested in equipment, and herd charges were 10.4 per cent of the capital invested in the herd. The combined cost of buildings, equipment, and herd was 12.6 per cent of the total capital invested in them. (Table 8.)

Fifty-six per cent of the cost of milk was due to feed, bedding, and pasture, 16.8 per cent to labor, 2.6 per cent to depreciation on cows, and 24.6 per cent to other costs. There was a credit of 6.2 per cent for calves and 7.4 per cent for manure. (Table 9.)

The average incomes from milk during the first winter and summer were not sufficient to meet the average costs during those seasons. In the second year the incomes were above the average costs in both seasons. (Table 10.)

The greater percentage of the year's income was received in the winter, but the feed, pasture, and bedding costs were heavier at this time and exceeded the summer costs by a greater percentage than the winter receipts exceeded the summer receipts. (Table 11.)

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